Phys 131 2016

Lecture 6

Fri: HW0, SPS

Monday: Warm Up 3

Tues: Discussion/quiz

Ch3 Conc Q 2

Ch3 Probs 6, 12, 22, 25, 30

Survey: Lectures? What will lectures do?

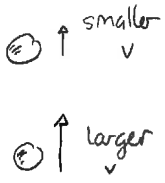
* teach material, practice problems, material, help with assignments, introduce concepts, clarify text
* ALSO – not "downloading" info
  – engaging with material

During class – clarify concepts, misconceptions etc, ...

Free fall motion

Consider an object launched vertically and subsequently only under the influence of Earth's gravity. It slows down and clear the acceleration is negative

What about a falling object?



$\Rightarrow a < 0$

Quiz 1 ~~80%~~ 95% } 90%

Quiz 2 ~~50%~~ 50%-90% } 60% - 80%

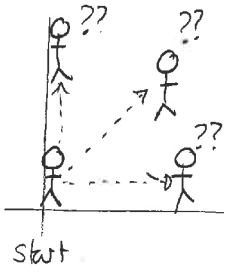
or

Quiz 3 20% – 50% } 60% – 65%

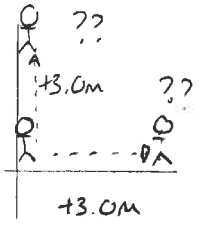
Motion in Two Dimensions: Displacement Vectors

An object that moves in one dimension can move along one of two directions and the direction can be adequately described by using a + or − sign. However, an object that moves in two dimensions can move in one of infinitely many directions and a sign will no longer be enough to describe the direction of motion.

Example: Suppose that a person starts moving in the corner of the room. If we are told that the person moves 3.0m, we cannot describe the person's final location – there are many possibilites, all 3.0m from the initial location.



Even if we are told that the person moves +3.0m (vs. −3.0m) we could not say which of two possible directions this would indicate.

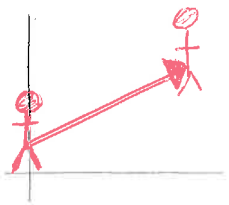


One number and a sign will not be enough to describe motion in two dimensions. We will introduce a new type of mathematical quantity – vectors – that will successfully describe such motion and which can be used in calculations.

First we define:

Displacement = Change in position of an object

The previous examples show that this is different to the distance traveled. Then we will describe any displacement by a vector. For the moment



A displacement vector is an arrow
i) tail at the initial location
ii) head/tip at the final location

We can see that the displacement vector contains two pieces of information:

1) a magnitude (or size) = distance between initial + final points

2) a direction = direction in which arrow points

The vectors that we will use always have both magnitude and direction and, in this sense, differ from conventional numbers (called scalars). We will develop mathematics for such vectors. This includes:

1) vector algebra – adding, subtracting, multiplying vectors
2) vector calculus – differentiating, integrating vectors

First we describe a standard vector notation

Vector

- size + direction

$\vec{A}$ ← arrow

magnitude of vector

- only size / magnitude
- magnitude never negative

A = length of vector ← no arrow

Displacement vectors are often represented as:

$\Delta\vec{r}$ = vector from initial to final location ← size and direction

with magnitude

Δr = distance from initial to final location ← size only

The first piece of mathematics is:

Two vectors $\vec{A}$ and $\vec{B}$ are equal $\Leftrightarrow$ $\vec{A}, \vec{B}$ have same magnitude AND same direction

Quiz 4 30% - 80% } 60% - 90%

Vector Addition and Subtraction

An intuitive definition for adding two displacement vectors is to follow two displacements successively.

Demo: PhET Vector Addition

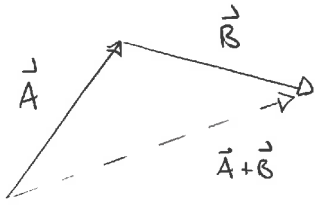
1) grid and two vectors
2) line up head to tail Ex 3.1
3) show sum

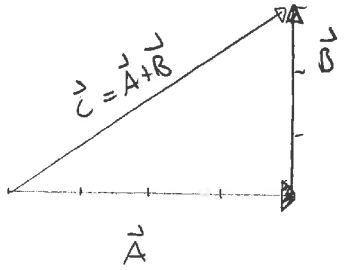
In general

> If $\vec{A}$ and $\vec{B}$ are two vectors then
>
> $\vec{A}+\vec{B}$ = single vector the gives same displacement when starting at tail of $\vec{A}$ and ending at head of $\vec{B}$ after the tail of $\vec{B}$ is shifted to head of $\vec{A}$

head-to-tail method

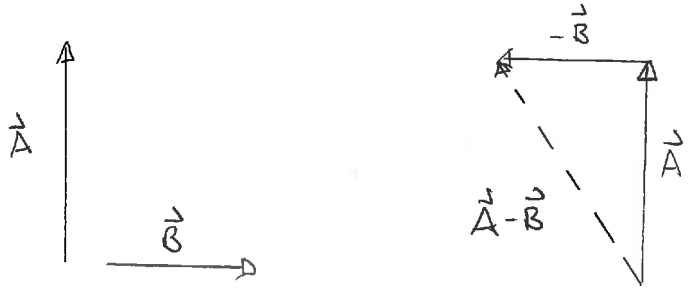
Adding two vectors cannot be done, in most cases, by just adding their magnitudes. The following example illustrates this





Here $A = 4cm$, $B = 3cm$ and $C = 5cm \neq A+B$.

Subtracting a vector is the same as adding a vector in the reverse direction.



Multiplying a Vector by a Number (Scalar Multiplication)

We can define multiplication of a vector so that it is consistent with repeated addition, e.g.

$$\vec{A} + \vec{A} + \vec{A} = 3\vec{A}$$

In general multiplication by a number is defined as.

> Let $\vec{A}$ be a vector and c any number. Then
>
> $c\vec{A}$
>
> is a vector with
>
> 1) Magnitude $|c|\,A$
> 2) direction = same as direction of $\vec{A}$ if $c>0$
> 3) " = opp to " of $\vec{A}$ if $c<0$

Example: With $\vec{A}$ as we have $-1.5\vec{A}$

Quiz 5 50%